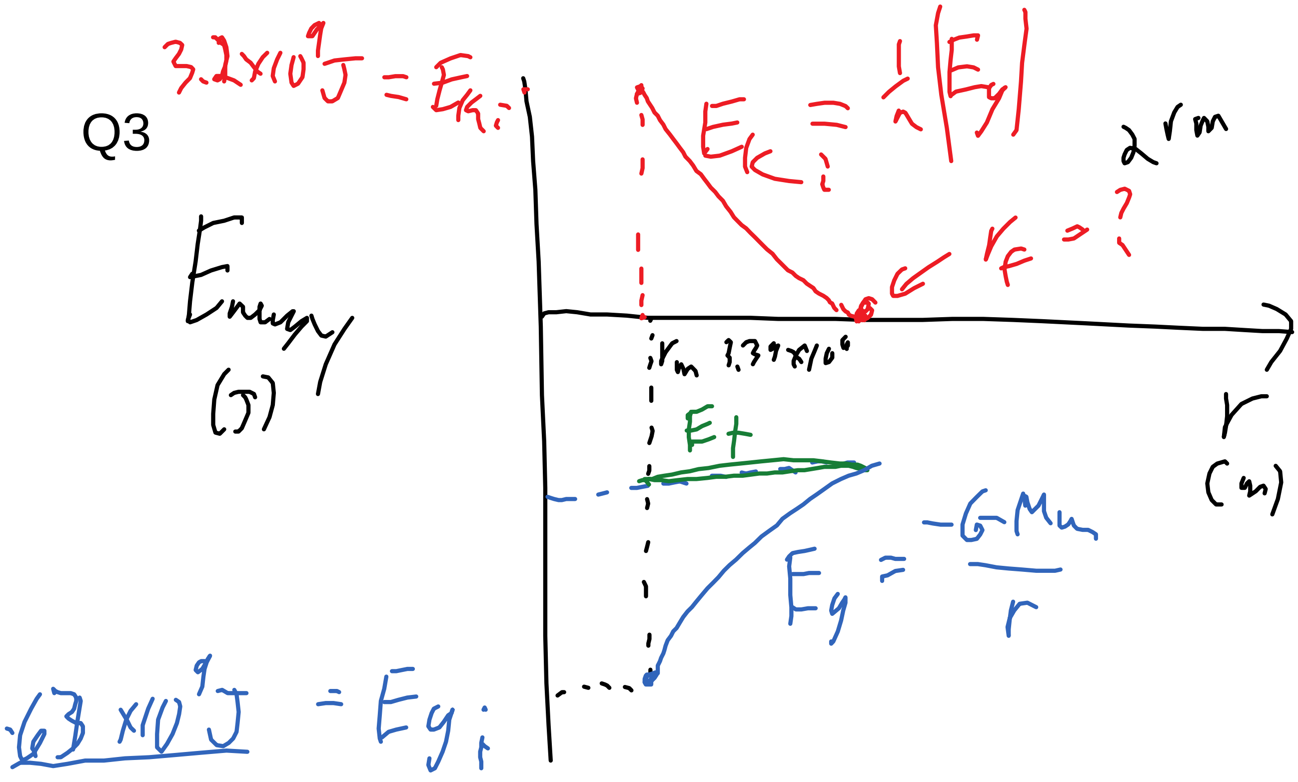
Friday, January 08, 2016 8:48 AM

Draw the graph of
Eg, Ek and Et Et, is total energy Eg+Ek on y axis vs h or r on the x axis for :

1. A projectile shot up to 100m from Mars' surface
2. A projectile shot with enough kinetic energy to escape Mars' gravitational field - to infinity (escape speed)
3. A projectile with half escape kinetic energy
4. A projectile with double the escape energy
5. The set of objects in uniform circular motion orbiting Mars at various r

Set a scale for each of the graphs using a 500 kg rocket at surface of Mars
$M=6.42 \times 10^{23}$kg
R = 3 390 km

Q3



$\Delta E = -\Delta E$ $\frac{1}{2}|E_g|$

$$\Delta E_g = -\Delta E_k$$

$$E_{kf} \qquad E_{ki} = \tfrac{1}{2}|E_{gi}|$$

$$\cancel{-}\cancel{G}Mm\left(\frac{1}{r_f} - \frac{1}{r_i}\right) = 0 \cancel{+} \frac{\cancel{G}Mm}{2r_i}$$

$r_f = ?$

$$\frac{1}{r_f} - \frac{1}{r_i} = -\frac{1}{2r_i}$$

$$\frac{1}{r_f} = \frac{1}{2r_i}$$

$$\boxed{r_f = 2r_i}$$

$$E_{T_i} = E_{T_f} \quad *$$

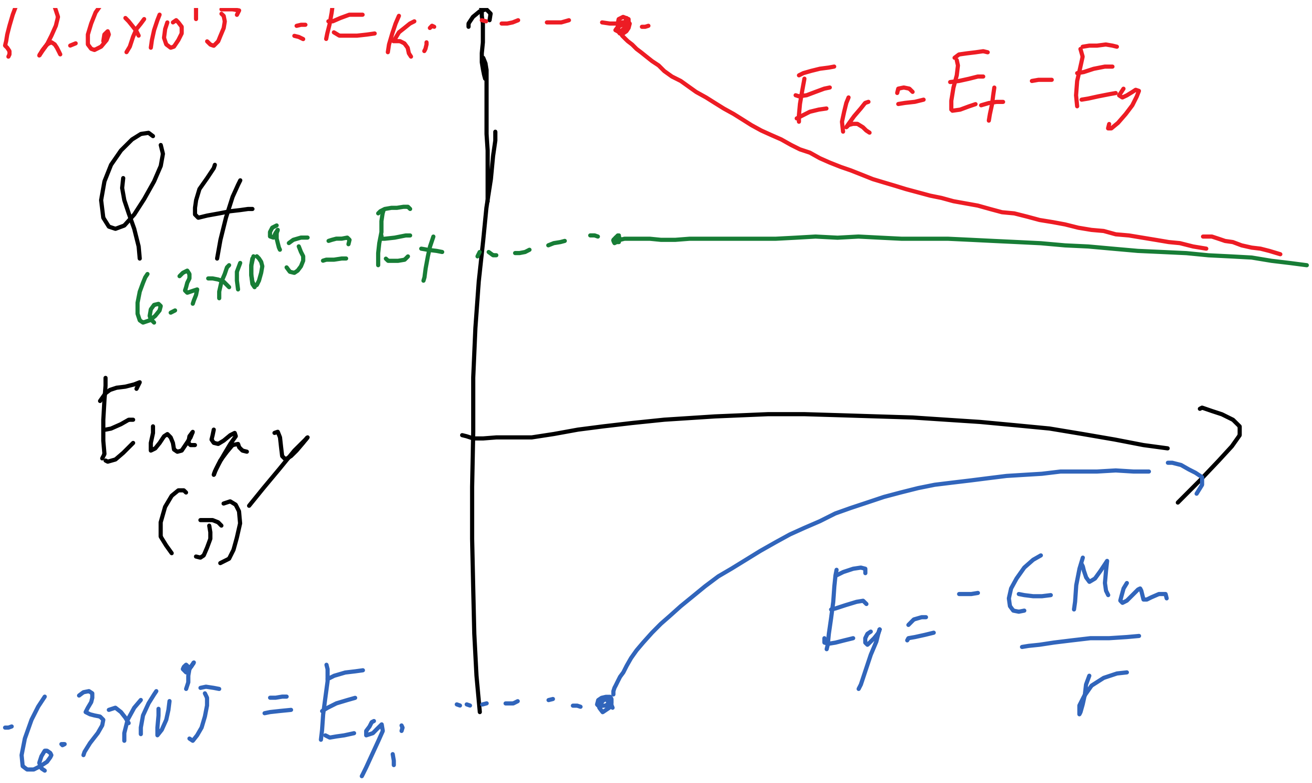
$$E_{g_i} + E_{k_i} = E_{g_f} + E_{k_f}$$

$$E_{g_i} - E_{g_f} = E_{k_f} - E_{k_i}$$

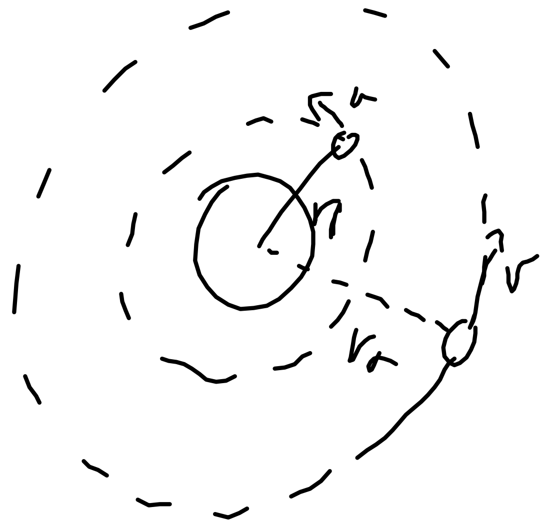
$(2.6\times10^9\ J = E_{ki}$

$E_k = E_T - E_g$

Q4



Q5



for orbits: $F_g = F_c$ *

$$\frac{GMm}{r^2} = \frac{mv^2}{r} = \frac{m4\pi^2 r}{T^2}$$

$$v^2 = \frac{GM}{r}$$

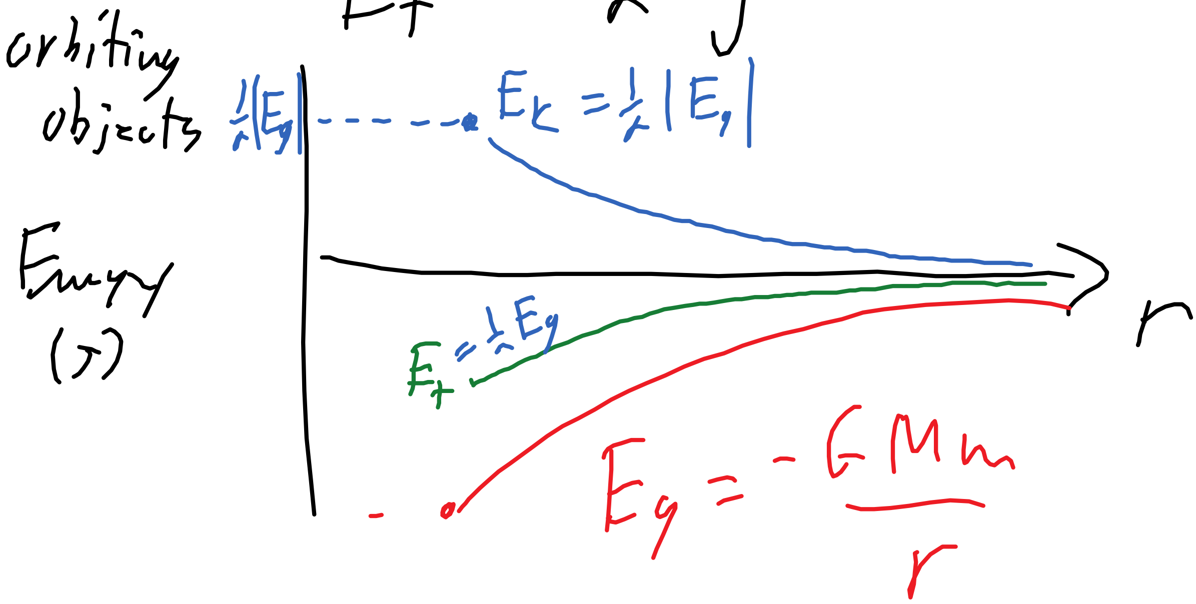
$$E_K = \frac{1}{2} m v^2 = \frac{1}{2} m \frac{GM}{r}$$

$$\cancel{E_K = \frac{1}{2} m v^2} = \frac{1}{2} \frac{GMm}{r} = \frac{1}{2}|E_g|$$

$$E_t = E_k + E_g$$

$$= \frac{1}{2}|E_g| + E_g$$

$$E_t = \frac{1}{2} E_g$$



Momentum and Impulse (chapter 7)

Define:
Inertia, momentum, impulse, Newton's Third Law, Law of conservation of momentum

Inertia - tendency to not accelerate - stay at rest or in straight line, constant speed motion. Related to mass.

Momentum - the product of mass and velocity
$p=mv$
Units: kgm/s
Vector quantity!! (watch out, E_k is a scalar, don't get them mixed up)
Vector diagrams required

Impulse- change in momentum or the

Newton's second law - $F_{net}=ma=m\Delta v/\Delta t$
$m\Delta v = F_{net}\,\Delta t$
$\Delta p= F_{net}\,\Delta t$ = area under the F_{net} - t graph
(watch out, E_k is the area under the F_{net} - d)
Impulse is the change in momentum or the net force acting over a period of time

Newton's third law: for every force A acts on B, B responds with an equal and opposite force.

So for every collision and explosion, the force between the objects is equal and opposite, the time of contact is equal so
Impulse is equal and opposite
Therefore the net impulse on the system is 0.
Total momentum is conserved if forces are all internal to the system.

Eg.

1. A 1.0 kg cart with a spring is pushed into a 2.0 kg cart. If they start at rest and spring

apart, what is the velocity of the 2.0kg cart if the 1.0kg cart moves off at 6.0 m/s? What is the average force on the cart if the spring pushes for 0.20s?

2. A 1.0 kg cart moving at 6.0 m/s hits a 2.0 kg cart moving at -2.0 m/s. What is the velocity fo the 1.0 kg cart after the collison if

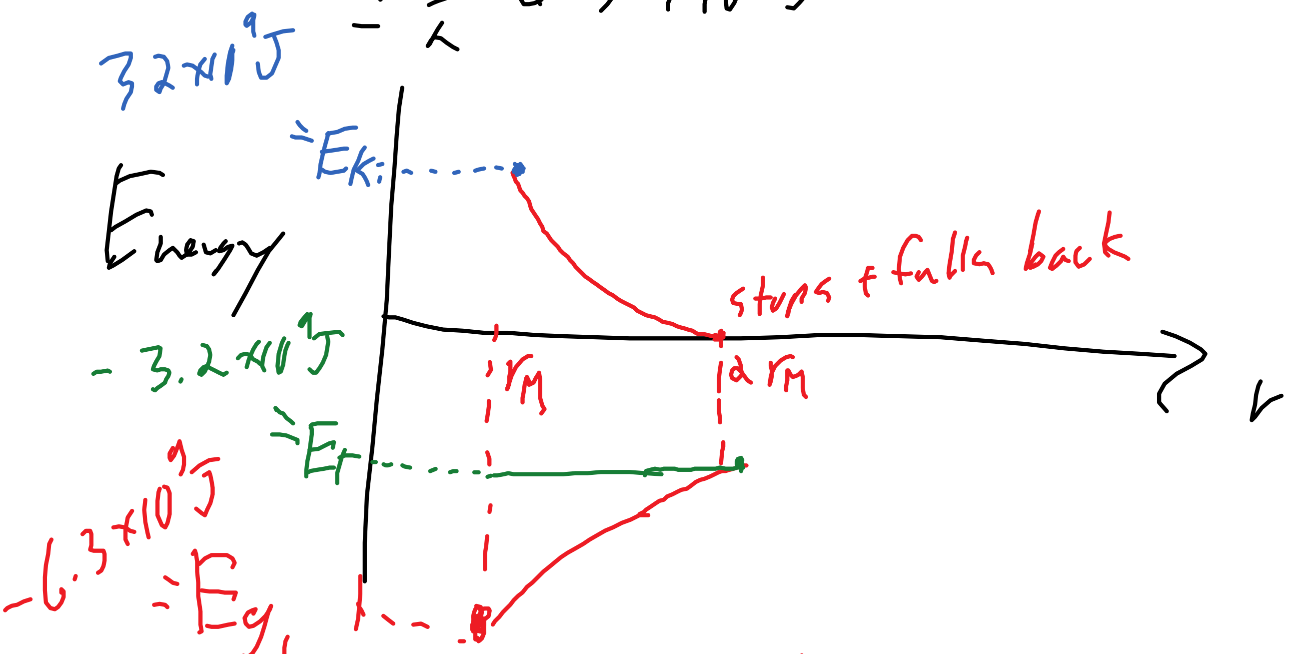
a) They stick together?

b) The 2.0 kg cart bounces off at +2.0 m/s?

Block 1-1

$$E_k = \frac{1}{2} \text{ escape energy}$$

$$= \frac{1}{2}\, 6.3\times10^{9}\,J = 3.2\times10^{9}\,J$$



$$E_{k_i} = \frac{1}{2}\left|E_g\right| \qquad E_{k_f} = 0$$

$$E_{g_i} = -\frac{GMm}{r_i} \qquad E_{g_f} = \frac{1}{2} E_{g_i}$$

$$E_{total_i} = E_{total\,f}$$

$$E_{g_i} + E_{k_i} = E_{g_f} + \cancel{E_{k_f}} \rightarrow 0$$

$$-\frac{\cancel{GMm}}{r_i} + \frac{\cancel{GMm}}{2r_i} = -\frac{\cancel{GMm}}{r_f} + 0$$

$$-\frac{1}{r_i} + \frac{1}{2r_i} = -\frac{1}{r_f}$$

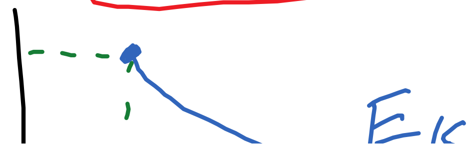
$$-\frac{2}{2r_i} + \frac{1}{2r_i} = -\frac{1}{r_f}$$

$$-\frac{1}{2r_i} = -\frac{1}{r_f}$$

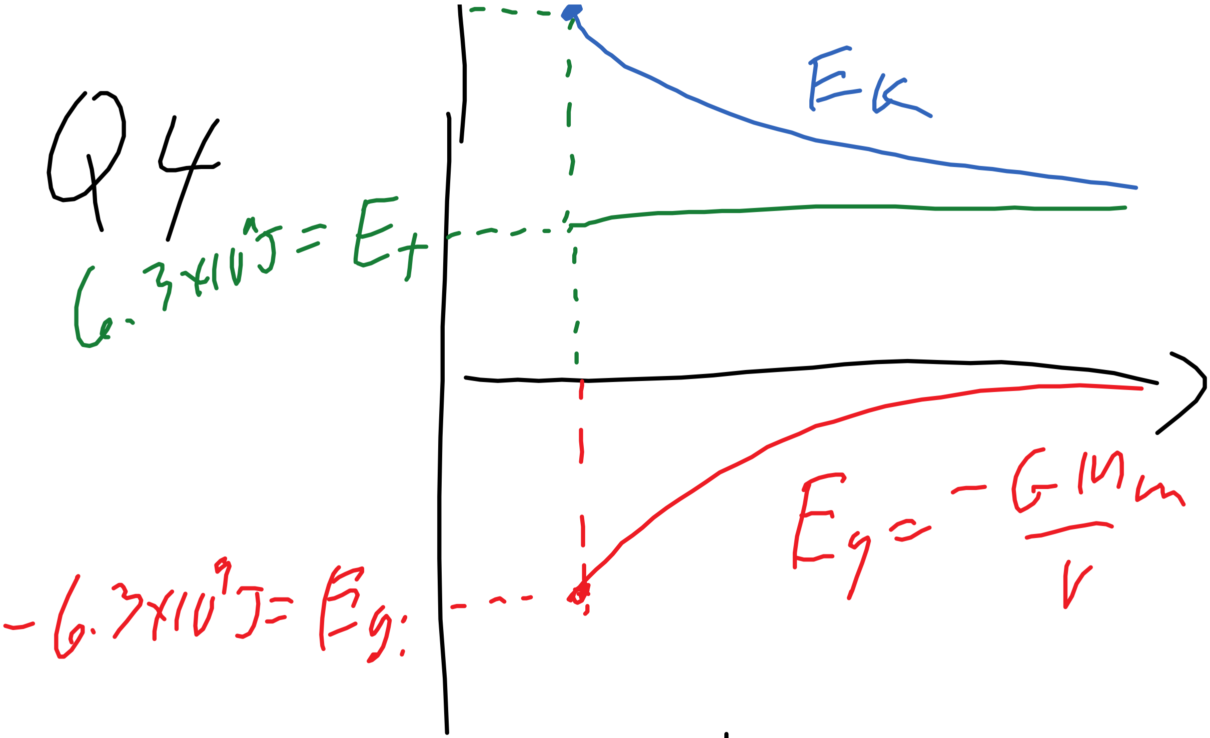
$$\boxed{r_f = 2r_i}$$

$2 \times 6.3 \times 10^{9}$

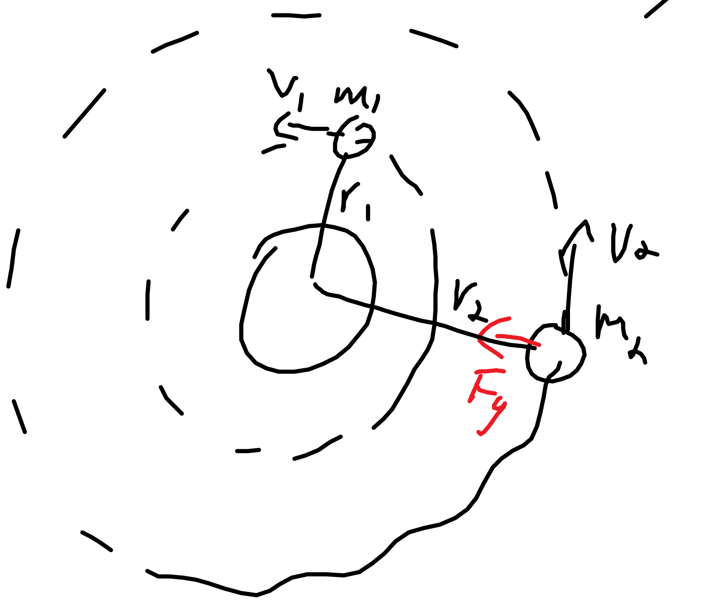
$= 12.6 \times 10^{9}\,J = E_K$



Q4



Q5 - orbiting Satellites



orbits: $F_g = F_c$ *

$\boxed{GMm = mv^2 = m4\pi^2 r}$

$$\boxed{\frac{GMm}{r^2} = \frac{mv^2}{r} = \frac{m4\pi^2 r}{T^2}}$$

$$E_K = \frac{1}{2}mv^2 \qquad \frac{GM\cancel{m}}{r^{\cancel{2}}} = \frac{\cancel{m}v^2}{\cancel{r}}$$

$$v^2 = \frac{GM}{r}$$

$$E_K = \frac{1}{2}m\frac{GM}{r}$$

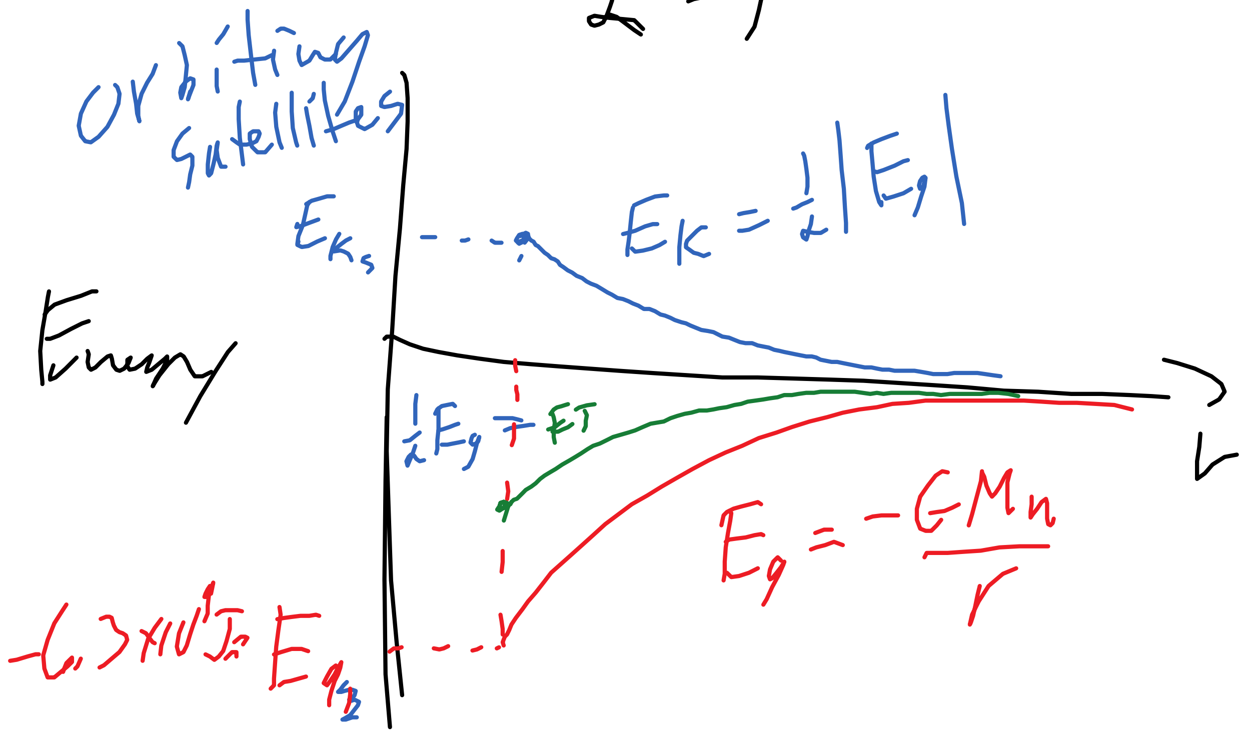
$$E_K = \frac{1}{2}\frac{GMm}{r}$$

$$E_K = \frac{1}{2}|E_g|$$

$$E_T = E_g + E_K$$

$$= E_g + \frac{1}{2}|E_g|$$

$= \frac{1}{2} E_g$



Define:

Inertia, momentum, Newton's second Law, impulse, Newton's third Law, Law of conservation of momentum

Block 1-2

Draw the graph of

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Set a scale for each of the graphs using a 500 kg rocket at surface of Mars
M=6.42 x 10^{23}kg
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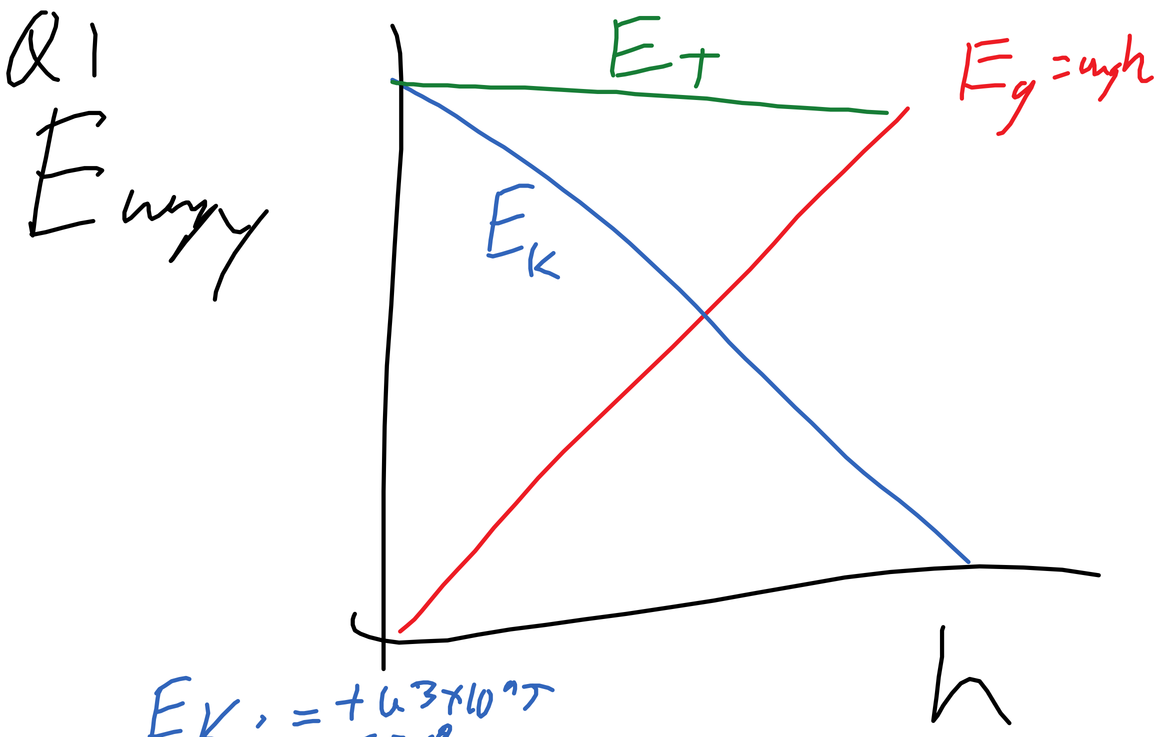
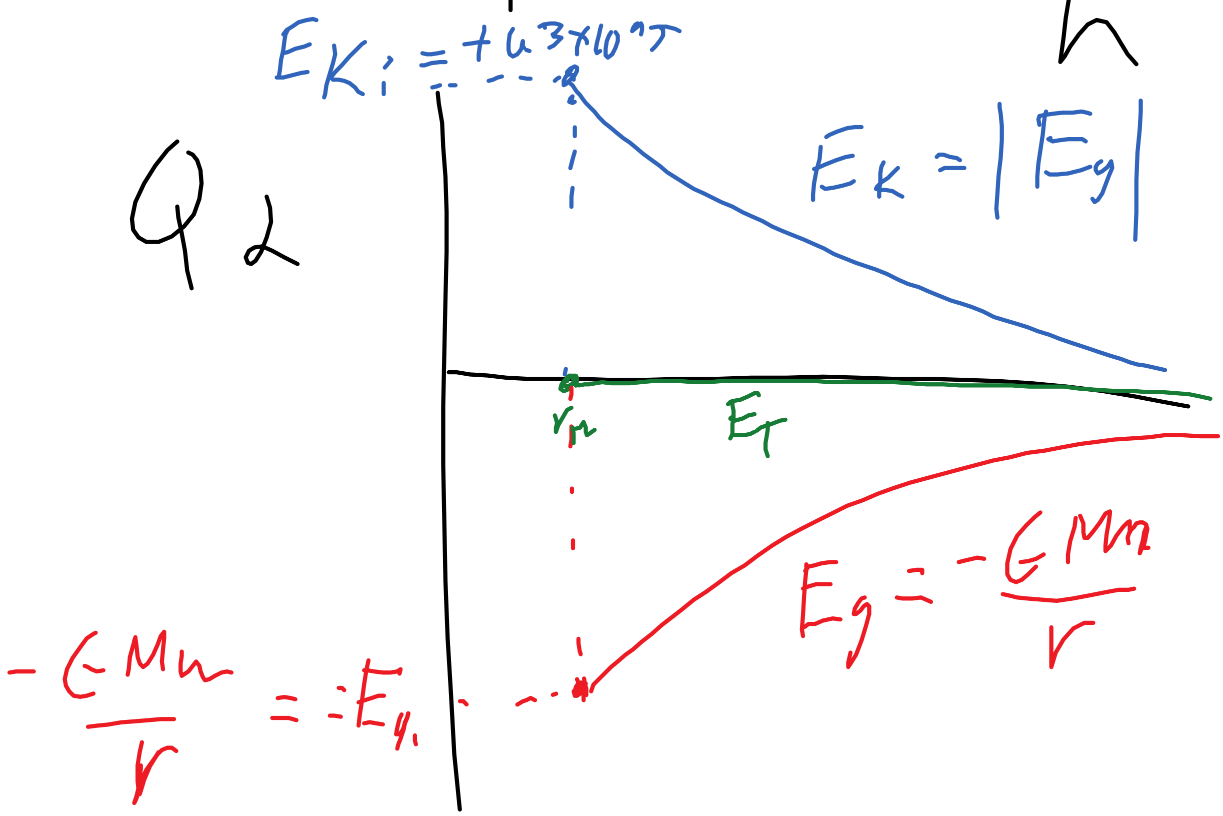




-6.3×10^{9} J

Q3 -

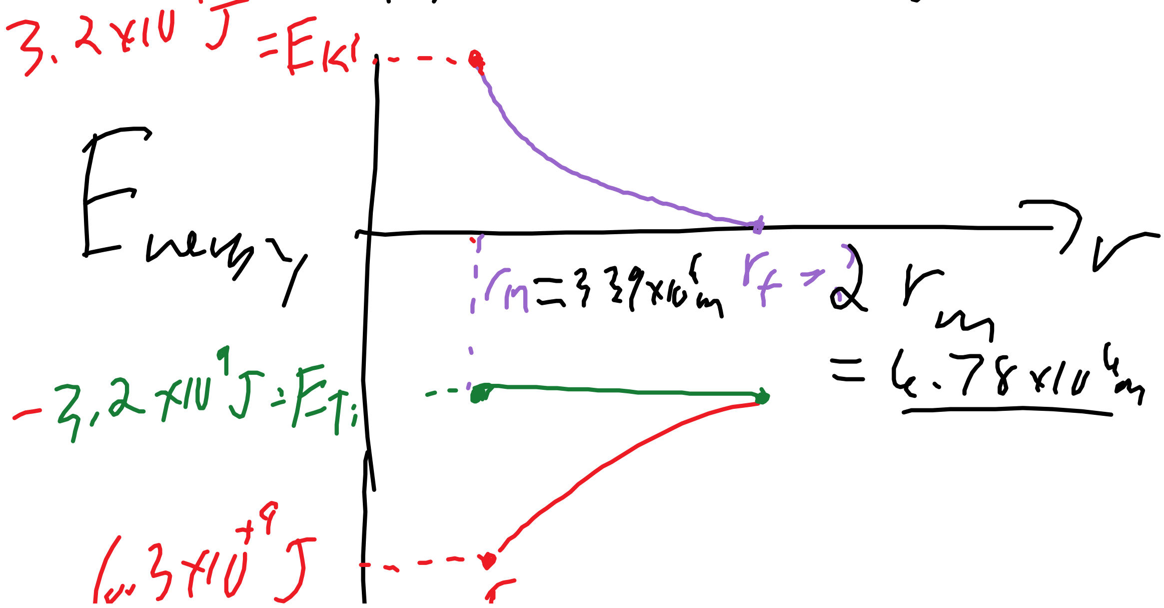
for escape $E_K = |E_g|$

set $E_K = \frac{1}{2}|E_g| = \frac{1}{2}\,6.3\times10^{9}\,J$

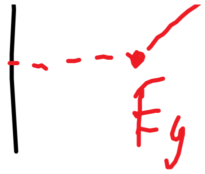
$= 3.2\times10^{9}\,J$

$E_T = E_K + E_g$

$= \frac{1}{2}|E_g| + E_g = \frac{1}{2}E_g$



$6.3\times10^{+4}\,J$



$E_{T_i} = E_{T_f}$ if no Energy is lost

$$E_{g_i} + \underbrace{E_{k_i}}_{=\frac{1}{2}|E_g|} = E_{g_f} + E_{k_f}$$

$$-\frac{\cancel{GMm}}{r_m} + \frac{\cancel{GMm}}{2r_m} = -\frac{\cancel{GMm}}{r_f} + 0$$

$$-\frac{1}{r_m} + \frac{1}{2r_m} = -\frac{1}{r_f}$$

$$-\frac{2}{2r_m} + \frac{1}{2r_m} = -\frac{1}{r_f}$$

$$-\frac{1}{2r_m} = -\frac{1}{r_f}$$

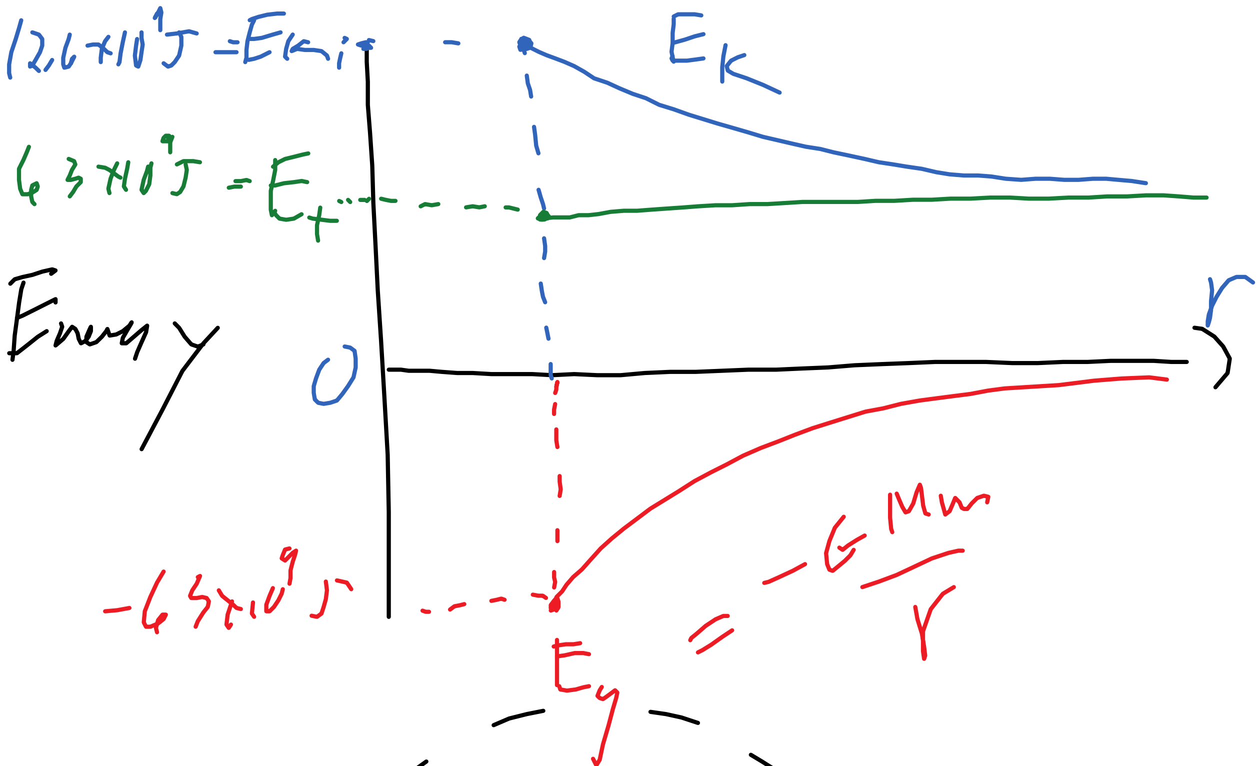
$$\boxed{r_f = 2 r_m}$$

Q4

$Ek_i = 2|Eg| = 2 \times 6.3 \times 10^9 J = 12.6 \times 10^9 J$

$E_t = Eg + Ek = -6.3 \times 10^9 J + 12.6 \times 10^9 J$

$Et = +6.3 \times 10^9 J$



Q5

as r increases,

E_k decreases

E_g increases (less negative)

E_T increases

Orbits $\quad F_g = F_c$ *

$$\frac{GMm}{r^2} = \frac{mv^2}{r} = \frac{m4\pi^2 r}{T^2}$$

$$E_K = \frac{1}{2}mv^2 \qquad \frac{GM\cancel{m}}{\cancel{r}} = \frac{\cancel{m}v^2}{\cancel{r}}$$

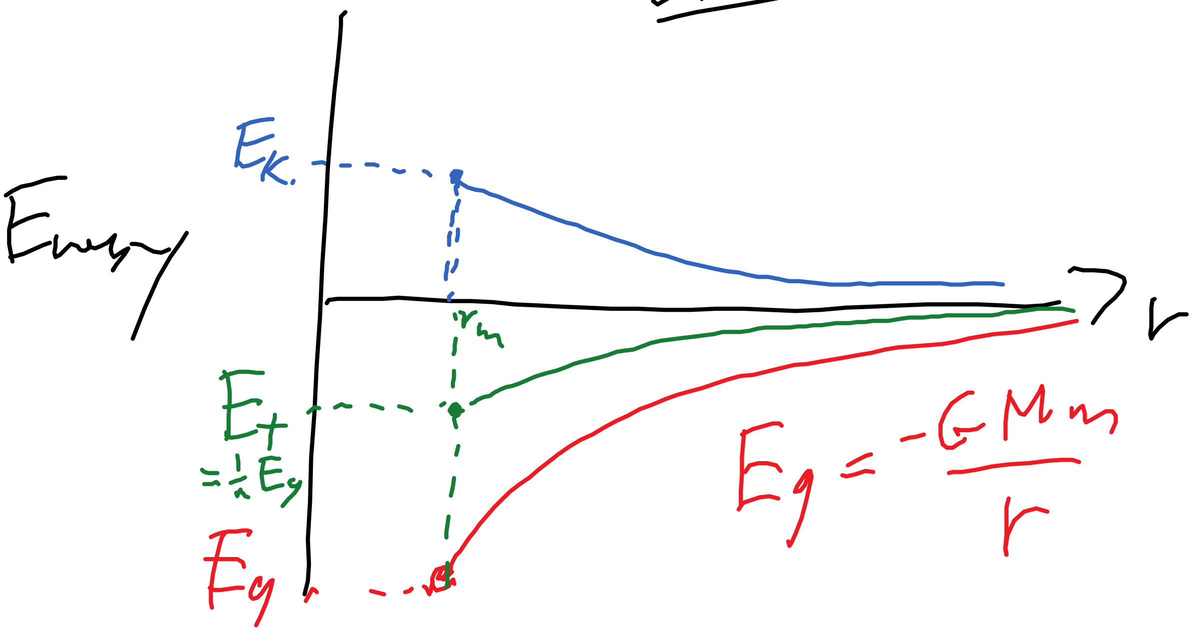
$$E_K = \frac{1}{2}m\frac{GM}{r} = \frac{1}{2}\frac{GMm}{r}$$

$$E_K = \frac{1}{2}|E_g|$$

$$E_T = E_g + E_K = E_g + \frac{1}{2}|E_g|$$

$$E_T = \frac{1}{2}E_g$$

— orbits



Finish gravitational energy handout
Define:
Inertia, momentum, Newton's second law, impulse, Newton's third law, conservation of momentum
Quiz Jan 14 gravitational energy
Quiz Jan 22 Momentum
Lab doubleblocks Investigation 2 method 1 report due Jan 26
Momentum energy test Jan 28